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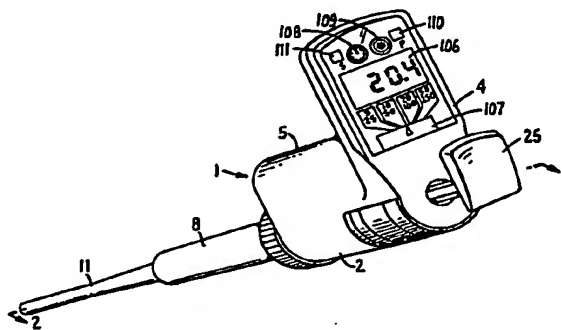
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(71) Applicant: **AMERICAN HOSPITAL SUPPLY CORPORATION**, One American Plaza, Evanston, IL 60201 (US)(43) Date of publication of application: 18.09.85
Bulletin 85/38(72) Inventor: **Oppenlander, Jon E.**, 1604 Reliez Valley Road, Lafayette California 94549 (US)
Inventor: **Koball, Bruce, R.**, 1518 Sixth Street, Berkeley California 94710 (US)
Inventor: **Shackelford, Carl L.**, 2686 Brian Road, San Pablo California 94806 (US)
Inventor: **Karna, Benn**, 6832 Mokelumene Street, Oakland California 94605 (US)(84) Designated Contracting States: **DE FR GB IT**(74) Representative: **Seaborn, George Stephen et al, c/o Edward Evans & Co. Chancery House 53-64 Chancery Lane, London WC2A 1SD (GB)**(54) **Hand-held pipette with disposable capillary.**

(57) A hand-held manually operated pipette having an adjustable plunger stroke and calibrated electronic digital volumetric display (106) draws-up and dispenses viscous, dense or high vapor pressure liquids by means of an easily replaced, disposable integral, positive displacement type plunger tip (10) and capillary (11) assembly. The pipette in another form utilizes a disposable air displacement capillary. The plunger adjustably strokes to a first stop (51) in a first mode for calibration or sample draw-up and dispensing with the volume of pipette liquid contents continuously displayed. In a second mode an over-travel arrangement enables the plunger shaft (23) to stroke beyond the first stop to permit collet type attachment and ejection of the integral plunger tip and capillary for positive displacement service or to eject an air displacement capillary.

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HAND-HELD PIPETTE WITH DISPOSABLE CAPILLARY

This invention relates generally to a hand-held pipette with disposable capillary and more particularly to a pipette having a handle, a replaceable and disposable capillary tip assembly and a body extender to provide an interface between the tip assembly and handle.

BACKGROUND OF THE INVENTION

Laboratory techniques frequently require repetitious handling of very small samples of liquids, for example, in the range 1 to 250 microliters. Various pipetting devices are commercially available to simplify these otherwise laborious pipetting procedures. Some of the pipetting devices are described in the prior patent art including U.S. patents 3,606,086; 3,815,790; 3,827,305; 3,918,308; 4,054,062; and 4,084,730. Another commercially available device is illustrated in Figs. 3 and 4. It includes a disposable, integral capillary and plunger tip assembly wherein the plunger tip is collet attached to an adjustable plunger stroking mechanism carried in the pipette handle to which the capillary is separately attached. In a first mode, the plunger stroking mechanism moves the capillary tip within the capillary for liquid pick-up or dispensing and in a second mode over-travels to permit ejection or attachment of the plunger tip and capillary assembly. A lead screw adjustment permits variation of the plunger stroke with a visual readout for the stroke setting.

Although some of the referenced patented devices use air displacement capillary tips, the device of Figs. 3 and 4 employs only a positive displacement type capillary and plunger tip with collet-type attachment for the plunger tip and a stroke adjustment which may produce errors in calibration.

1 SUMMARY OF THE INVENTION

2 The described invention provides a means for continuous and
3 accurate readout of the volumetric contents of the pipette which
4 is independent of stroke adjustment and a calibration means and
5 tip configuration which reduce errors in calibration to permit
6 less rigorous manufacturing tolerances that do not affect the
7 accuracy of operation.

8 The invention uses a first stop in a calibration or liquid
9 pick-up and dispense mode as a zero reference point for mea-
10 suring the desired plunger stroke. With the first mode stroke
11 at the first stop, over-travel of the plunger shaft in a second
12 mode enables ejection or attachment of an integral capillary and
13 plunger tip assembly. That capillary and plunger tip assembly
14 mounts upon the pipette with the plunger tip in its zero refer-
15 ence position and collet secured before any return movement com-
16 mences. The plunger tip and capillary at the zero reference
17 contain no fluid whatsoever. This insures that the plunger tip
18 zero reference and volumetric measurement of the pick-up and
19 dispense mode are synchronized. With the first stop as a
20 zeroing reference, the pipette is automatically calibrated with
21 the measuring system electronically and volumetrically zeroed.
22 Electronic display means counts up from the zero reference at the
23 first stop to the other end of the variably adjusted first mode
24 stroke. It displays the volume to which the stroke has been
25 adjusted and thereafter may, for example, continuously display
26 the volume of liquid contents in the pipette.

27 The principal object of this invention is to provide a
28 pipette with a common body or handle which houses the volumetric
29 stroking mechanism, control and display; a set of disposable
30 capillary tip assemblies for a wide range of volumes; and a body
31 extender providing an interface between the disposable tip
32 assembly and body or handle that is easily removed for auto-

1 claving or for exchange of body extenders having different func-
2 tions such as so-called "repettor" or air displacement or posi-
3 tive displacement functions.

4 Another object of the invention is to provide an unbreak-
5 able, disposable, integral, positive displacement type tip
6 assembly including a capillary with an interior peripheral
7 shoulder and a plunger tip that are calibrated to a zero volu-
8 metric reference simply by attachment of the tip assembly to the
9 body extender and the stroking mechanism within the body or
10 handle.

11 Another object of the invention is to provide within the
12 body or handle a plunger stroking mechanism which uses a first
13 stop of a dispensing or pick-up mode as a zero reference for
14 stroke adjustment and calibration.

15 An object of the invention is an electronic display selec-
16 tively to readout continuously the volumetric contents of the
17 pipette up to the calibrated stroke setting or to continuously
18 display the volume of liquid dispensed up to that set volume.

19 Another object of the invention is to provide means for
20 presetting an electronic display mounted on the pipette body to
21 accommodate various size capillary and plunger tip assemblies.

22 One other object of the invention is to provide in the
23 plunger stroking mechanism an over-travel arrangement which
24 picks up the capillary and plunger tip assembly in a calibrated
25 position without affecting the pipette volumetric zero refer-
26 ence.

27 Still another object of the invention is to provide a
28 simple tip assembly ejection means that can be positively de-
29 activated by an eject lock.

30 An object of the invention also is a stroke adjusting means
31 that does not affect volumetric calibration and which may be
32 locked at a particular volumetric setting.

1 Other objects and advantages of the invention will become
2 apparent upon consideration of the following written description
3 and the accompanying drawings.

4 BRIEF DESCRIPTION OF THE DRAWINGS

5 Fig. 1 is a perspective view of the hand-held pipette with
6 a disposable, positive displacement type plunger tip and capil-
7 lary;

8 Fig. 2 is a sectional view of the pipette of Fig. 1 taken
9 along line 2-2 of Fig. 1;

10 Fig. 3 is a partial sectional view of a prior art adjust-
11 able stroke pipette with disposable, positive displacement type
12 tip assembly;

13 Fig. 4 is an enlarged sectional view of the plunger tip
14 collet for the prior art pipette of Fig. 3;

15 Fig. 5 is a sectional view of the body extender, collet and
16 collet closure for the plunger tip assembly of the dispenser
17 shown in Figs. 1 and 2;

18 Fig. 6 is a view, partially in section, of the plunger tip
19 and flanged end of the capillary which assemble to the compo-
20 nents shown in Fig. 5;

21 Fig. 7 is a sectional view of the body extender, collet and
22 collet closure of Fig. 5 in the eject mode of operation;

23 Fig. 8 is a sectional view of the stroke adjusting and
24 eject locking means for the pipette of Figs. 1 and 2;

25 Fig. 9 is an end view of the eject locking means taken
26 along line 9-9 of Fig. 8;

27 Fig. 10 is a partial sectional view of the locking teeth of
28 the adjusting screw lock means taken along line 10-10 of Fig. 8;

29 Fig. 11 is an exploded view of the collet closure tube,
30 collet rod and encoder carrier assembly;

31 Fig. 12 is an enlarged sectional view of the plunger tip
32 and capillary assembly;

1 Fig. 13 illustrates the plunger tip and capillary assembly
2 seated on a mounting rack; and

3 Fig. 14 is a schematic diagram of a form of electronic
4 circuit used for calibration, display and indication of various
5 operating states for the pipette of Figs. 1 and 2.

6 DESCRIPTION OF PRIOR ART DEVICE IN FIGS. 3 AND 4

7 The pipette illustrated in Figs. 3 and 4 includes a tubular
8 body or handle 201 to which is threaded a body extender 208 that
9 receives at one end an integral tip assembly including plunger
10 tip 210 and capillary 211. A plunger shaft 223, hexagonal in
11 section, manipulated by an operator's thumb on plunger button
12 225 slides in a hexagonal central bore 222 in adjusting lead
13 screw 221 threaded in an adjusting nut 220 formed at one end of
14 a central plunger cavity 203 in the body extender 208. A piston
15 224 at the end of plunger shaft 223 drives a collet rod 284
16 carrying at its opposite end a serrated collet 280 in opposition
17 to a stiff collet closure spring 292 bearing on a shoulder of
18 the collet rod and collet closure tube 275. A return spring 230
19 seated at one end upon a shoulder 231 formed in body extender
20 208 and seated at its other end on a shoulder 350 formed in
21 collet closure tube 275 urges the plunger assembly to its fully
22 retracted position shown. The collet closure spring 292 is
23 stiffer than return spring 230 so it normally urges the collet
24 closure 276 into engagement with the collet 280 to maintain it
25 securely closed around the rod end 260 of the plunger tip 210 as
26 the plunger assembly strokes in a pick-up and dispense mode.

27 The adjusting lead screw 221 can be threaded in adjusting
28 nut 220 by manual rotation of the hexagonal plunger shaft 223
29 within the hexagonal central plunger bore 222. The adjusted
30 stroking volume is displayed on mechanical micrometer means 351
31 within the pipette body 201 which is operable directly by the
32 adjusting screw.

1 The illustrated capillary 211 has molded in one end annular
2 retaining groove and rib 352 that seat upon corresponding annu-
3 lar retaining groove and rib 353 formed upon the end of body
4 extender 208. The plunger tip 210 carries at one end a plunger
5 head 262 that strokes within a precision molded portion 263 of
6 the capillary 211 to pick up and dispense liquids as the plunger
7 strokes. At one extreme end of the stroke, head 262 abuts
8 shoulder 264 formed at the end of capillary 211. The head 262
9 has a necked-down end 354 which in that abutting position ex-
tends beyond the open end of capillary 211.

11 The plunger stroke in liquid dispensing or pickup mode is
12 controlled at one end by abutment of the plunger piston 224 with
13 the end of lead screw 221 and at the other end by abutment of
14 collet closure 276 with the shoulder 231 in body extender 208
15 upon which the return spring 230 also bears. Further depression
16 of the plunger shaft 223 by the operator then compresses the
17 stiffer collet closure spring 292 and moves the collet 280 away
18 from the stopped collet closure 276. This permits the collet to
19 open as shown in hidden lines in Fig. 4 and the plunger head 262
20 abutting the shoulder 264 in capillary 211 forces capillary
21 retainer groove and rib 352 out of engagement with retaining rib
and groove 353 on the body extender 208 and thereby ejects the
23 capillary 211 and plunger tip 210 assembly. Plunger tip pick-up
24 is accomplished by assembling the capillary 211 to the body ex-
25 tender 208 with the collet open in the tip ejection mode shown
26 in Fig. 4. This pushes a plunger tip flange 355 into engagement
27 with the end of collet 280 in opposition to the direct pressure
28 exerted by the operator's thumb on plunger button 225. Release
29 of that pressure then closes the collet as it returns under
30 force exerted by collet closure spring 292 into collet closure
31 276 with the plunger tip flange 355 and collet 280 as shown in
32 solid lines in Fig. 4.

1 During pick-up, the plunger tip 210 moves the plunger head
2 262 from its abutment with capillary shoulder 264 until the
3 collet becomes closed so that, when the collet closure 276 then
4 retracts from shoulder 231 in the dispensing or liquid pick-up
5 mode, the plunger tip head 262 may not be at a zero reference
6 against capillary shoulder 264.

7 DESCRIPTION OF A PREFERRED EMBODIMENT

8 The embodiment of the invention illustrated in Figs. 1 and
9 2 includes a molded plastic handle or body 1 having an elongated
10 barrel 2 with a central plunger cavity 3 and a lid portion 4
11 extending generally at right angles to the barrel portion 2 upon
12 which mount an electronic display and various indicating means
13 described hereinafter. A body cover 5 encloses the related
14 display electronics and provides a comfortable gripping surface
15 for the operator's fingers below the display mounted upon the
16 body lid 4.

17 An extender nut 6 threads upon mating threads 7 molded in
18 the end of barrel portion 2 of the body 1 to secure to one end
19 of the body a generally tubular body extender 8 which extends
20 the central plunger cavity 3 of the body 1 as at 9 and carries
21 at its free end the disposable, integral positive displacement
22 type plunger tip 10 and capillary 11 assembly shown in Fig. 2.

23 The end of the central plunger cavity 3 remote from body
24 extender 8 has a threaded stroke adjusting nut 20 secured to the
25 barrel portion 2 of the body 1. An adjusting screw 21 threads
26 through the adjusting nut 20 and has a central circular bore 22
27 through which passes plunger shaft 23 carrying at one end piston
28 24 and at its other end a plunger button 25 for stroking manipu-
29 lation by the thumb of the operator's hand. The plunger shaft
30 23 protrudes through a hole 26 in the end 27 of encoder carrier
31 28 within the central plunger cavity 3 of the body. The plunger
32 shaft 23 is resiliently connected to encoder carrier 28 by means

1 of conical thrust lock spring 29 bearing upon the plunger piston
2 24 and the end 27 of the encoder carrier 28.

3 Return spring 30 seated at one end upon a shoulder 31
4 formed by the end of tubular body extender 8 and at the other
5 end upon encoder carrier 28 urges the plunger assembly, in-
6 cluding encoder carrier 28 and plunger shaft 23, to its normally
7 retracted position wherein the encoder carrier 28 abuts ad-
8 justing screw 21 for stroke length control as shown in Fig. 2.

9 A knurled adjusting knob 35 having a smooth interior bore
10 36, which fits over the adjusting screw 21, threads the ad-
11 justing screw 21 through the fixed adjusting nut 20 by means of
12 a pair of protruding ears 37 integral with the adjusting screw,
13 each of which tracks in a separate longitudinal slot 38 formed
14 along the adjusting knob interior bore 36. The adjusting screw
15 is shown in its withdrawn position for maximum stroke length in
16 Fig. 8 and in one extended position in Fig. 2.

17 The adjusting screw 21 can be locked at any position such
18 as the partially extended one of Fig. 2 by means of an adjusting
19 lock ring 40, more clearly illustrated in Figs. 8 and 10. The
20 adjusting lock ring 40 has a low cam portion 41, a high cam
21 portion 42 and a ramp cam portion 43 which connects them. The
22 high cam portion 42 moves a separate toothed lock segment 44
23 into engagement with mating teeth 45 carried along a circular
24 annulus in one end of the knurled adjusting knob 35. The low
25 cam portion 41 permits the teeth of segment 44 and 45 to dis-
26 engage. The adjusting lock ring 40 is guided through a small
27 arc of travel between one end of adjusting nut 20 and an abut-
28 ment 46 on knurled adjusting knob 35. A retainer segment 47
29 retains the lock segment 44 in position over the lock ring ramp
30 portion 43 and the low and high cam portions 41,42 adjacent to
31 it.
32

1 In a first calibration or liquid draw-up and dispense mode,
2 the operator by depressing plunger button 25 with a manipulating
3 thumb may stroke the plunger assembly from the position shown in
4 Fig. 2 or Fig. 8 that is adjustably set by stroke adjusting
5 screw 21 to the other stroke end which is fixed and established
6 by an abutment 50 on the encoder carrier 28 which at the end of
7 that dispensing stroke abuts a first stop 51 on the body barrel
8 portion 2. The length of the stroke can be adjusted by re-
9 leasing the adjusting lock ring 40 and turning the knurled
10 adjusting knob 35 to advance or retract the adjusting screw 21
11 through adjusting nut 20.

12 In its second tip eject or attachment mode, travel of the
13 encoder carrier 28 is restrained by the interference of abutment
14 50 and first stop 51. However, the plunger shaft 23 may over-
15 travel further forward through the hole 26 in the encoder car-
16 rier end 27 if the eject lock shown in Figs. 8 and 9 is not in
17 place. The eject lock prevents plunger shaft over-travel. It
18 includes an eject lock housing 52 having a central bore 53 of a
19 diameter sufficient to permit passage of plunger shaft 23 but
20 not sufficient to permit passage of the larger diameter cylin-
21 drical end 54 of plunger button 25. The eject lock is set by a
22 shiftable eject lock plate 55 to prevent over-travel of the
23 plunger shaft 23 more than slightly beyond the end of the dis-
24 pense stroke with abutment 50 and stop 51 engaged. The eject
25 lock plate has an eccentric hole 56 which in the position shown
26 in Fig. 9 is not axially aligned with and does not permit pas-
27 sage of the cylindrical end 54 of the plunger button 25. This
28 restrains motion of the plunger shaft 23 to that which is
29 slightly beyond the stroke end determined by encoder carrier
30 abutment 50 and body stop 51. In the eject unlocked position,
31 protrusion 57 on the eject lock plate 55 moves from the lock
32 detent 58 as shown in Fig. 9 to unlock detent 59 to hold the

1 plate unlocked. In that latter position, the eccentric hole 56
2 in the eject lock plate 55 is concentric with the plunger axis
3 and its larger diameter permits passage of the smaller cylin-
4 drical end 54 of the plunger button. This enables over-travel
5 of the plunger shaft 23 in a second mode for capillary and
6 plunger tip attachment or ejection.

7 Figs. 5, 6 and 7 illustrate the attachment and eject mode
8 for the positive displacement plunger tip and capillary assembly
9 shown in Figs. 1 and 2. The plunger tip 10 includes an elon-
0 gated rod portion 60 having a chamfered end 61 and the other end
11 formed with a plunger tip head 62 that fits tightly within the
12 precision molded bore 63 of the capillary 11. The end of the
13 capillary 11 adjacent to the precision molded bore 63 has an
14 interior peripheral shoulder 64 against which the plunger tip
15 head 62 abuts in its fully extended position with the plunger
16 tip head 62, the extremity of which extends slightly beyond the
17 end of capillary 11. The length of bore 63 of the capillary is
18 at least commensurate with the plunger stroke. Adjacent to the
19 precision molded bore 63 the capillary has a generally tapering
20 bore 65 enlarging to the connecting end of the capillary which
21 carries a flange 66 that fits within the open end of extender
22 body 8. A canted annular spring 67 mounted in an annular groove
23 68 formed in the end of the extender body 8 holds the capillary
24 at shoulder 69 with the beveled face 70 of flange 66 seated
25 tightly against the corresponding beveled seat 71 formed in the
26 extender body end.

27 The plunger tip 10 and capillary 11 are an integral dis-
28 posable assembly. A set of them may be dimensioned so as to
29 provide a wide range of pipetting capacities. For example, the
30 embodiment shown is a 250 microliter assembly plunger tip made
31 from polyethylene, polypropylene, polymethylpentane or similar
32 inert and semi-rigid with the rod portion 60 .125 inches in

1 diameter and the head 62 having its largest diameter at $.1408 \pm$
2 $.0005$ inches to fit within a capillary having its precision
3 molded bore 63 at $.1393 \pm .0004$ inches in diameter. The inte-
4 rior angle of the peripheral shoulder 64 of the capillary is at
5 30° and mates with an identical 30° chamfer on the plunger tip
6 head 62. The chamfer 61 enables the plunger tip 10 to be in-
7 serted easily into the collet closure assembly shown in Figs. 2,
8 5 and 7. Other dimensional relationships between capillary bore
9 36 and plunger tip head 62 are employed for others of a set of
10 tip assemblies to a range of pipetting capacities.

11 As is further illustrated in Figs. 2, 12 and 13, the capil-
12 lary 11 is of enlarged diameter at a "parking place" 120
13 slightly in excess of the diameter of the head 62 of the plunger
14 tip adjacent to the precision molded bore 63 remote from in-
15 terior peripheral shoulder 64. During non-use and storage in
16 the parking place 120, the plunger tip head 62 is not under
17 compression as it would be within the precision molded bore 63
18 that has a smaller diameter than the head 62. Storage in the
19 parking place prevents the plunger tip head 62 from cold forming
20 to a smaller diameter that otherwise would affect the tight fit
21 required as the head strokes within the precision molded bore 63
22 of the capillary. Also, as shown more particularly in Figs. 12
23 and 13, the outer periphery of the capillary has a rack mounting
24 step 121 for abutment with a rack 125 perforated as at 126
25 within which the capillary and plunger tip assemblies can be
26 mounted with the plunger rod 60 protruding upwardly for stab
27 type attachment to the pipette body of a new capillary and
28 plunger tip assembly as hereinafter described.

29 The collet closure means includes a collet closure tube 75
30 which at one closed end abuts piston 24 of the plunger shaft 23
31 and at its other end carries a collet closure 76. The collet
32 closure 76 has a neck 77 that in the capillary eject mode moves

1 into the throat 78 at the end of body extender 8 by over-travel
2 of the plunger shaft to extend the collet closure tube 75 into
3 the position shown in Fig. 7. In that eject mode, the neck 77
4 of the collet closure 76 passing through throat 78 abuts capil-
5 lary 11 and forces it off the extender body despite the reten-
6 tion force provided by canted spring 67. In this eject position
7 of Fig. 7, the conical closure surface 79 of the collet closure
8 76 moves away from the serrated collet 80 both to permit ejec-
9 tion of an already attached capillary and plunger tip assembly
10 and to enable insertion of a new plunger tip 10 into the ser-
11 rated collet 80 against collet seat 81 as shown in Fig. 7.
12 Collet seat 81 is spring biased by a light force spring 82
13 bearing against collet seat 81 and the threaded end 83 of collet
14 rod 84 to which the collet 80, itself, threads. The light force
15 collet spring 82 through collet seat 81 pushes the plunger tip
16 10 to the end of the mounted capillary 11 with plunger tip head
17 62 in engagement with capillary interior peripheral shoulder 64
18 and slightly beyond the end of the capillary. Collet shoulder
19 85 retains the spring biased collet seat 81 in the unloaded
20 condition of Fig. 5.

21 Collet rod 84 by means of collet pin 90 is pinned to en-
22 coder carrier 28 in a bayonet type thrust lock slot 28a with the
23 pin 90 passing through a pair of diametrically opposed elongated
24 slots 91 formed in collet closure tube 75 as shown in more
25 detail in Fig. 11. Thrust lock spring 29 holds the assembly
26 together. The collet rod 84 is normally urged by collet closure
27 spring 92 into the collet closed position shown in Figs. 2 and
28 5. The collet closure spring 92 bears at one end against the
29 closed end of the collet closure tube 75 and at the other end
30 against the collet closure rod 84 urging the conical collet
31 surface 93 into resilient engagement with the similarly conical
32 closure surface 79 of collet closure 76. The conical collet

1 closing surfaces pinch the serrated collet internal bore 94
2 together to hold the plunger tip 10 firmly in place against
3 collet seat 81. Collet closure spring 92 is stiff in comparison
4 with return spring 30, so that during the calibration or pick-up
5 and dispensing mode, spring 92 forces the collet closure and
6 collet surfaces 79,93 firmly together.

7 In this first mode, as described earlier, the plunger
8 assembly strokes between adjusting screw 21 at one end and
9 engagement between encoder abutment 50 and first stop 51 at the
10 other. This engagement prevents further compression of return
11 spring 30 and enables compression of the stiffer collet closure
12 spring 82. In the second eject or attachment mode, with the
13 eject lock not in place, the operator can then extend the plun-
14 ger to over-travel against the collet closure spring 82 and move
15 the collet closure 76 from the position shown in Fig. 5 to that
16 in Fig. 7 and thereby eject an attached plunger tip and capil-
17 lary assembly or enable pick up of a new one.

18 The capillary 11 and plunger tip 10 assemblies may be rack
19 mounted vertically on a laboratory bench or other support with
20 the plunger rod 60 protruding upwardly. Attachment of a new
21 capillary and plunger tip assembly then is easily done simply by
22 pushing the pipette body 1 down with the plunger shaft 23 and
23 collet closure 76 in the over-travel position of Fig. 7. This
24 engages the beveled flange face 70 of the capillary 11 against
25 beveled seat 71 in the body extender 8. The capillary flange 66
26 is held in seated relationship by canted spring 67 bearing
27 against capillary shoulder 69. Release of the plunger shaft
28 then closes the collet 80 around the rod portion 60 of the
29 plunger tip 10. The collet gripping position on the rod portion
30 60 is not critical because the plunger tip head 62 has already
31 been and remains seated at a zero volumetric reference against
32 capillary shoulder 64 by means of the bias of collet spring 82

1 against collet seat 81. The plunger tip does not move during
2 collet closure. Then, further release of the plunger shaft 23
3 moves the stroking mechanism through the zero volumetric refer-
4 ence at the first stop 51 with the plunger tip and capillary in
5 synchronism at their zero reference, too.

6 The electronic aspects of the described embodiment acquire,
7 process and display data related to the volume of liquid being
8 transferred by the pipette. Volume is derived from a linear
9 incremental position sensing means for the plunger assembly. It
10 comprises a potentiometer 99 having a linear resistive element
11 100 distributed within the pipette body barrel 2 along the
12 plunger assembly stroke within the central plunger cavity 3.
13 Potentiometer wiper 101 carried by the encoder carrier 28 is
14 biased against the resistive element 100 to derive a voltage
15 which is proportional to linear displacement of the plunger
16 assembly with respect to the zero volumetric reference with
17 carrier abutment 50 engaged with the first stop 51. That me-
18 chanical engagement is detected by zero volume switch 102 which
19 closes when engagement occurs. Battery 103 powers the related
20 electronics on circuit boards 104,105 mounted within body cover
21 105.

22 The block diagram of Fig. 11 illustrates schematically one
23 version of electronics mounted on boards 104,105 to operate a
24 liquid crystal display 106 on body lid 4. In a "volume con-
25 tained" mode, the liquid crystal continuously displays the
26 instantaneous volumetric content of the pipette up to the volume
27 set by adjusting screw 21. Slide switch 107 also on the body
28 lid 4 selects the volume range for a particular one of a set of
29 four capillary-plunger tip assemblies used in the described
30 embodiment. The illustrated electronics also may provide a
31 timer function as at 108 or in another mode displayed on the
32 liquid crystal 106. An alarm function on the body lid may be

1 provided by piezoelectric beeper 109. The body lid 4 also
2 mounts appropriate on-off push button 110 and mode select push
3 button 111.

4 The electronics illustrated in Fig. 11 include a CMOS gate
5 array device 115 which provides an interface between micropro-
6 cessor 116 and the linear potentiometer 99. The gate array
7 device 115 converts the analog voltage developed by potenti-
8 meter 99 which is proportional to the stroking distance of
9 travel of the plunger assembly from abutment at the first stop
10 51 to digital values supplied to the microprocessor. The gate
11 array device 115 includes a dual slope analog to digital conver-
12 ter which operates in a ratiometric mode to provide a latched
13 digital output which is indicative of the analog voltage sup-
14 plied by the linear potentiometer 99. A trimmer potentiometer
15 117 adjusts the wiper-displacement/converter-count ratio by
16 adjusting the converter full-scale reference voltage.

17 In the "volume contained" mode, liquid crystal 106 displays
18 the increasing pipette volume as the finger button 25 is re-
19 leased from the zero reference at first stop 51 to the upper
20 stroking limit set by adjusting screw 21 where the display reads
21 the pipette volume setting. As the finger button then is de-
22 pressed, the display reads the decreasing pipette volume of
23 liquid contained in the pipette until the zero volume position
24 again is reached at first stop 51. There the zero volume switch
25 102 resets the display 106 to zero.

26 In a "timer" mode, the operator may set the selected time
27 interval shown on timer 108 which is continuously counted down
28 in the display 106 by microprocessor 116 until an audible signal
29 may be activated such as piezoelectric beeper 107. The display
30 resets to the original interval to begin another cycle.

31 A variety of software routines and hardware components may
32 be employed to provide the described functions within the scope
of the invention defined in the following claims.

CLAIMS

1
2
3 1. In a pipette having a body carrying a plunger assembly
4 for manual stroking in a liquid pick-up and dispense mode to one
5 stroke-end at a first stop, the improvement comprising

6
7 electrical switch means on said stop to detect the presence of
8 said plunger assembly at said stroke-end;

9
10 linear position sensing means developing an electrical signal
11 porportional to the distance said plunger assembly strokes from
12 said first stop; and

13
14 means converting the electrical signal from said linear position
15 sensing means to a continuous display of volume.

16
17 2. The pipette of claim 1 wherein the display is the
18 volume of liquid contained in the pipette.

19
20 3. The pipette of claim 1 further comprising
21
22 means sensing the other end of the plunger assembly stroke and
23 resetting the display to zero volume; and
24
25 means converting the electrical signal from said linear position
26 sensing means to a continuous display of the volume of liquid
27 dispensed.
28
29
30
31
32

1 4. The pipette of claim 1 further comprising an adjusting
2 nut on the body;

3
4 an adjusting screw threaded in the adjusting nut; and

5
6 an adjusting knob for turning the adjusting screw in the ad-
7 justing nut to adjust the length of the plunger assembly stroke
8 with respect to said first stop.

9
10 5. The pipette of claim 4 further including a mechanical
11 lock selectively to prevent the adjusting knob from turning said
12 adjusting screw.

13
14 6. The pipette of claim 1 wherein the linear position
15 sensing means includes a potentiometer comprising

16
17 a linear resistive element distributed on the body along the
18 stroke of said plunger assembly; and

19
20 a wiper in electrical contact with the resistive element and
21 carried by the plunger assembly.

1 7. In a pipette having a body carrying a plunger assembly
2 including a plunger shaft for manual stroking in a liquid pick-
3 up and dispensing mode to one stroke-end at a first stop, a
4 plunger tip holding collet on the plunger assembly, a body
5 extender connected to the body and having a capillary receiving
6 end near said collet, an improved disposable capillary and
7 plunger tip assembly comprising (a) a capillary having a pre-
8 cision molded internal bore, an internal peripheral shoulder
9 adjacent that bore at one end of the capillary, a flange car-
10 rying a beveled seating face at the other end of the capillary
11 for releasable mounting upon the receiving end of said body
12 extender; and (b) a plunger tip having a head at one end for
13 reciprocation within the precision molded bore of the capillary
14 and a rod shaped end for insertion in said collet.

15
16 8. The pipette of claim 7 further including a spring
17 biased collet seat on the plunger assembly for urging the plun-
18 ger tip head into abutment with the interior peripheral shoulder
19 of the capillary.

20
21 9. The pipette of claim 8 further comprising
22
23 a collet closure;
24
25 a collet closure tube carrying the collet closure in shiftable
26 relation to said collet; and
27
28 a collet closure spring compressible by over-travel of the
29 plunger shaft and arranged to open and close the collet only
30 when said plunger assembly is at said one stroke end at said
31 first stop.

32

1 10. The pipette of claim 9 further comprising eject lock
2 means for restraining over-travel of said plunger assembly
3 beyond said first stop.
4

5 11. The pipette of claim 9 wherein the collet closure
6 spring urges the collet closure toward said first stop in order
7 to close said collet.
8

9 12. The pipette of claim 9 further comprising an eject
10 lock selectively to restrain over-travel of said plunger shaft.
11

12 13. In a pipette having a body carrying a plunger assembly
13 for manual stroking in a liquid pick-up and dispense mode, a
14 body extender connecting the body and having a capillary re-
15 ceiving end surrounding an internal bore, the improvement com-
16 prising
17

18 a beveled seat around said bore at the receiving end of said
19 body extender;
20

21 a capillary having a flanged end with a beveled seating face
22 corresponding to said beveled seat of the body extender;
23

24 and a canted annular spring secured within an annular groove at
25 the end of said body extender to hold the seating face of the
26 capillary flange against the seat of said body extender.
27
28
29
30
31
32

1 14. The pipette of claim 13 further comprising
2
3 a plunger tip holding collet on the plunger assembly; and
4

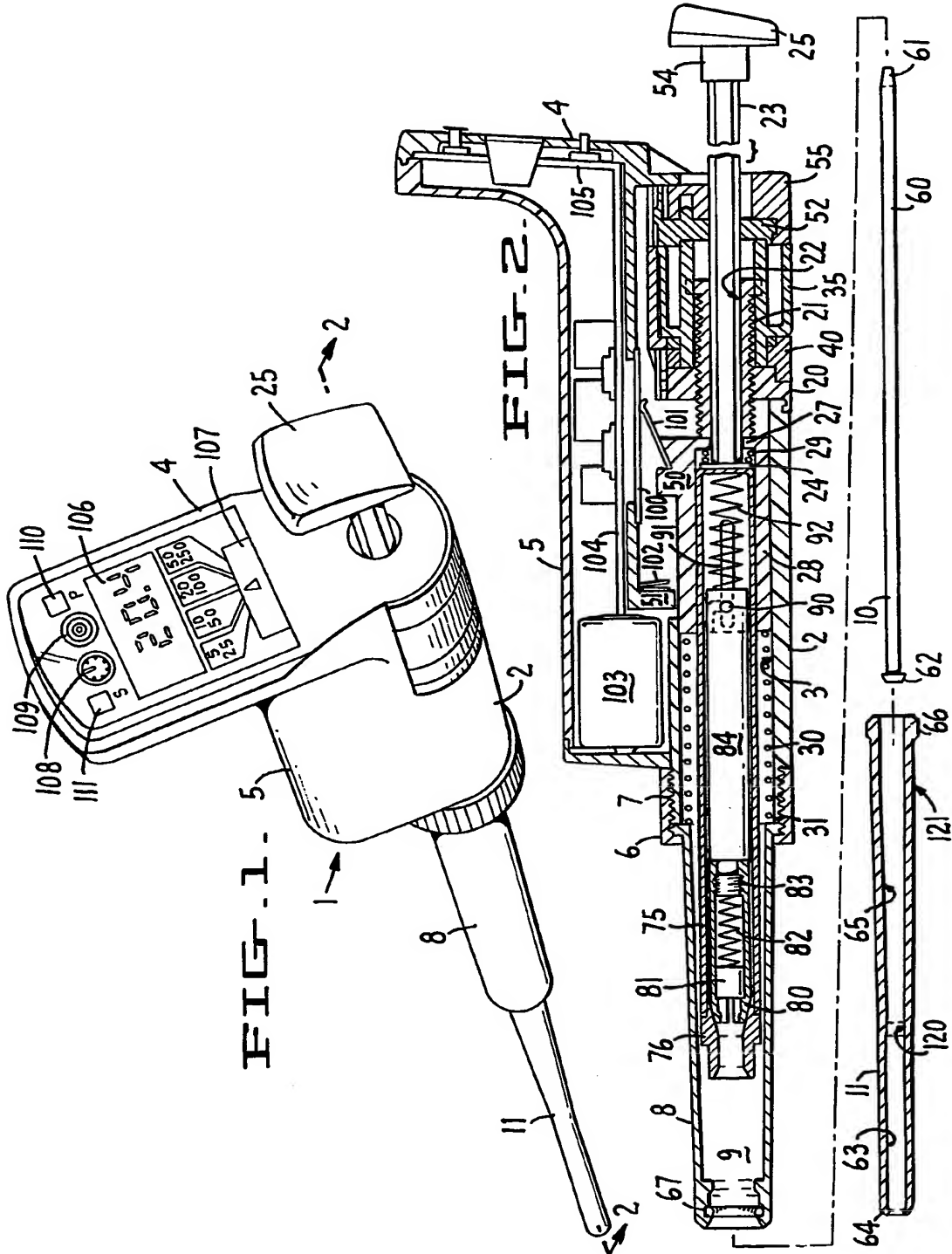
5 a collet closure for said collet having a necked down portion
6 that is shiftable through the body extender bore to eject a
7 seated capillary from the receiving end of said body extender.
8

9 15. The pipette of claim 14 wherein shifting of the neck
10 of said collet closure beyond that needed to eject said capil-
11 lary is restricted by a shoulder adjacent to said body extender
12 bore.
13

14 16. A disposable capillary and plunger tip assembly for a
15 pipette including (a) a capillary having a precision molded
16 internal bore and a parking place bore adjacent that precision
17 molded bore which has a diameter larger than the precision
18 molded bore; and (b) a plunger tip having a head for reciproca-
19 tion within the precision molded bore of the capillary which is
20 of a diameter larger than the precision molded bore but smaller
21 than the parking place bore.
22

23 17. The disposable capillary and plunger tip assembly of
24 claim 16 further including a rack mounting step around the
25 exterior of the capillary.
26

27 18. The pipette of claim 1 further comprising micropro-
28 cessor means for converting the electrical signal from said
29 linear position sensing means to a continuous display of volume
30 for any one of a set of disposable capillary and plunger tip
31 assemblies having different volumetric capacities.
32



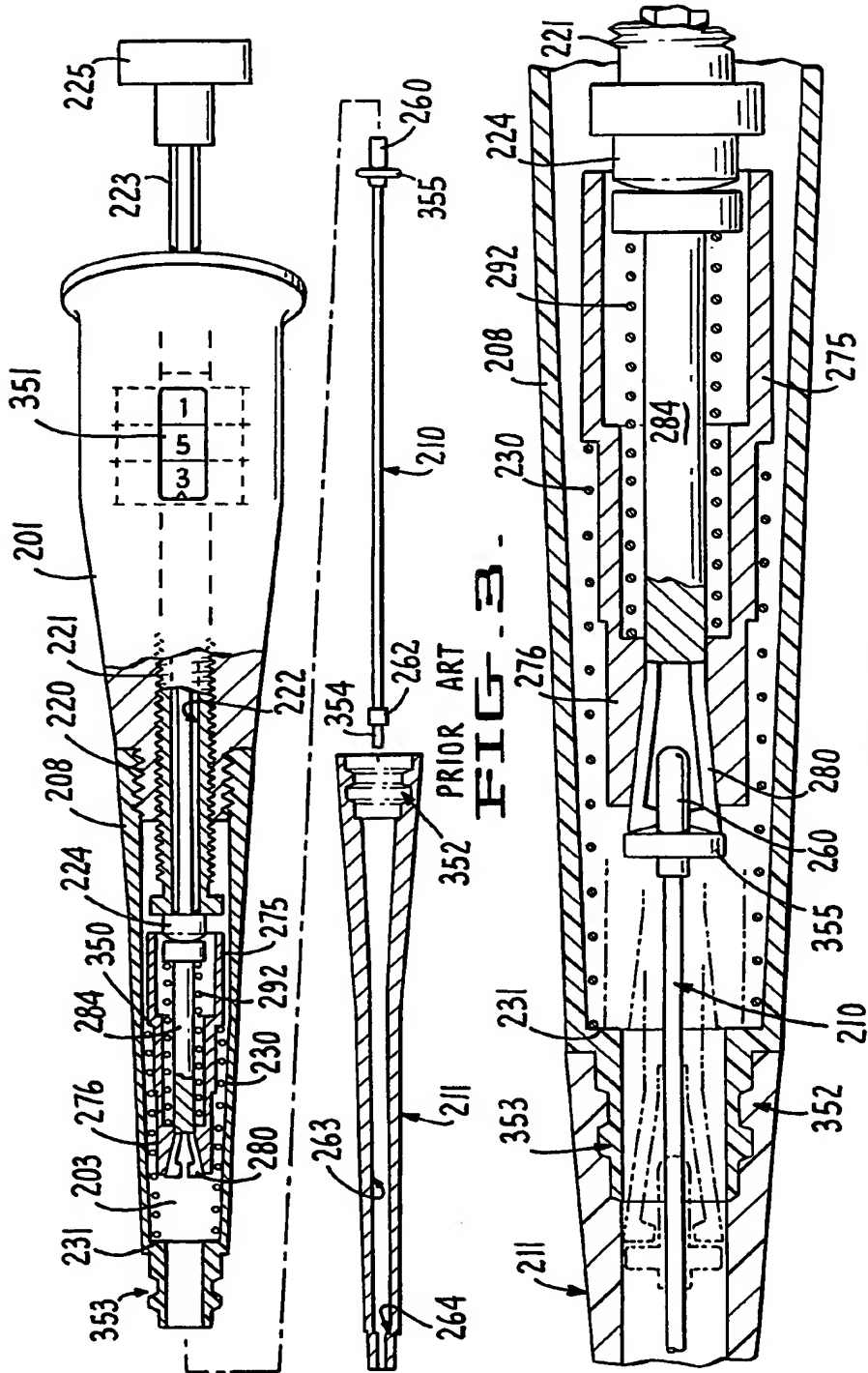
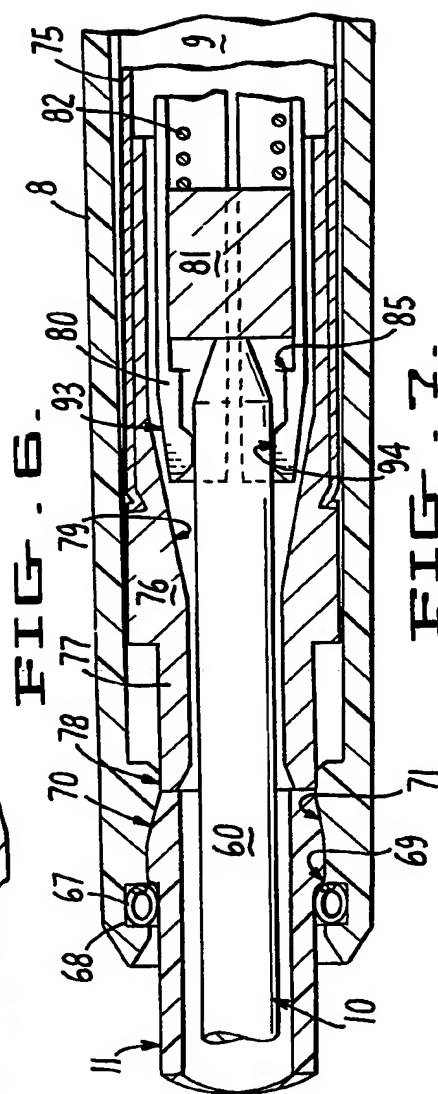
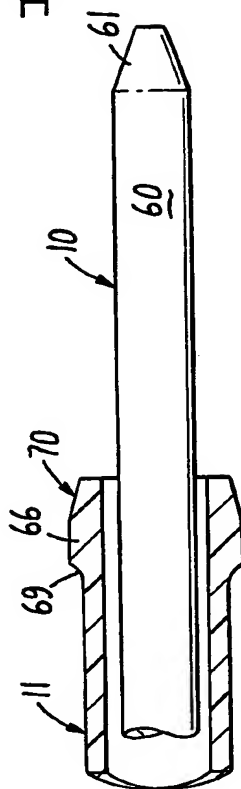


FIG. 3
PRIOR ART
FIG. 4



正工: 2.4

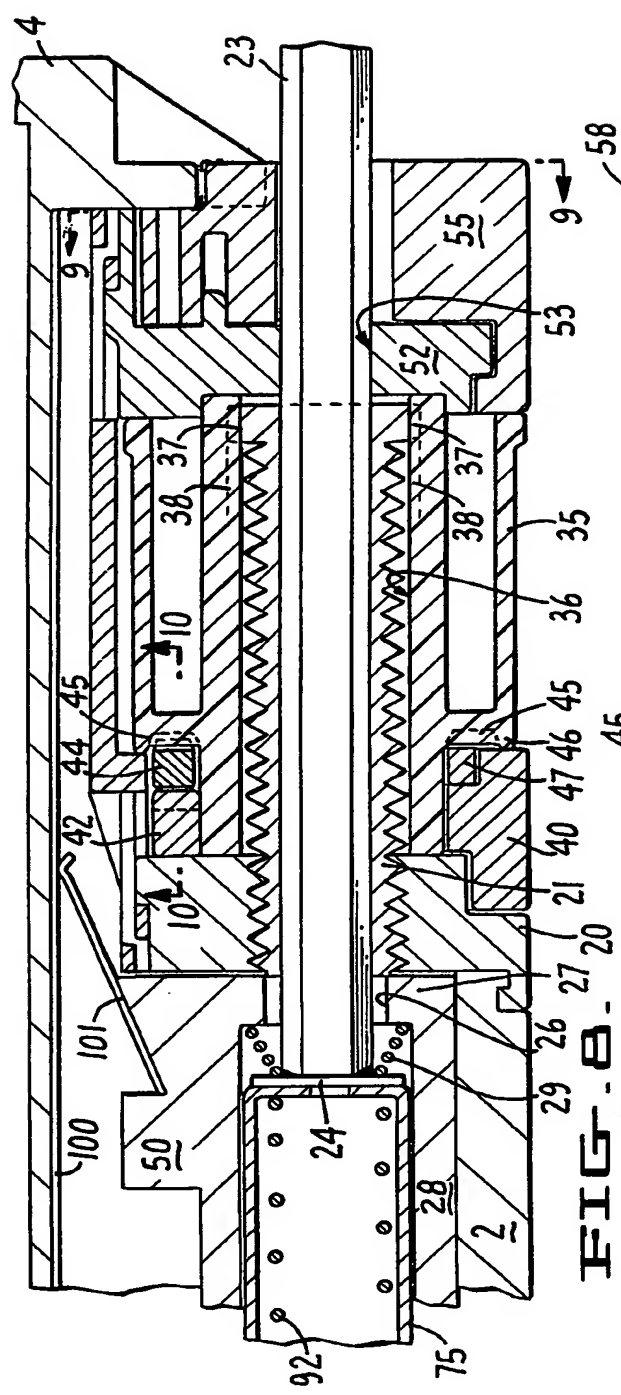


FIG. 8.

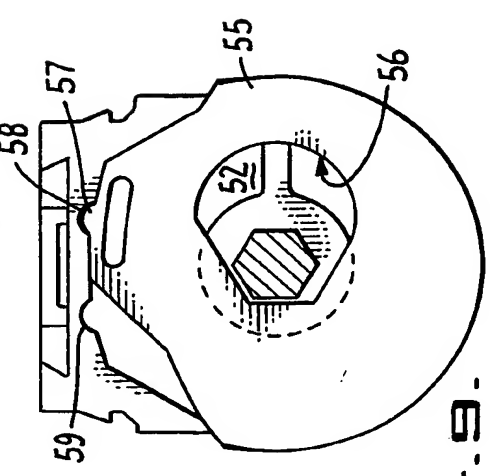


FIG. 9.

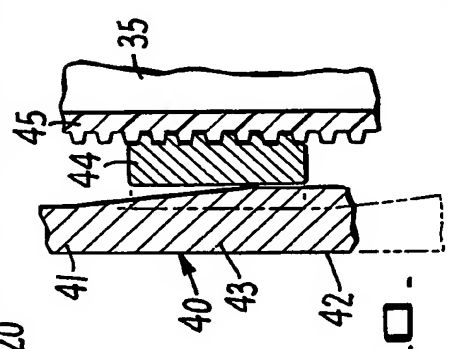
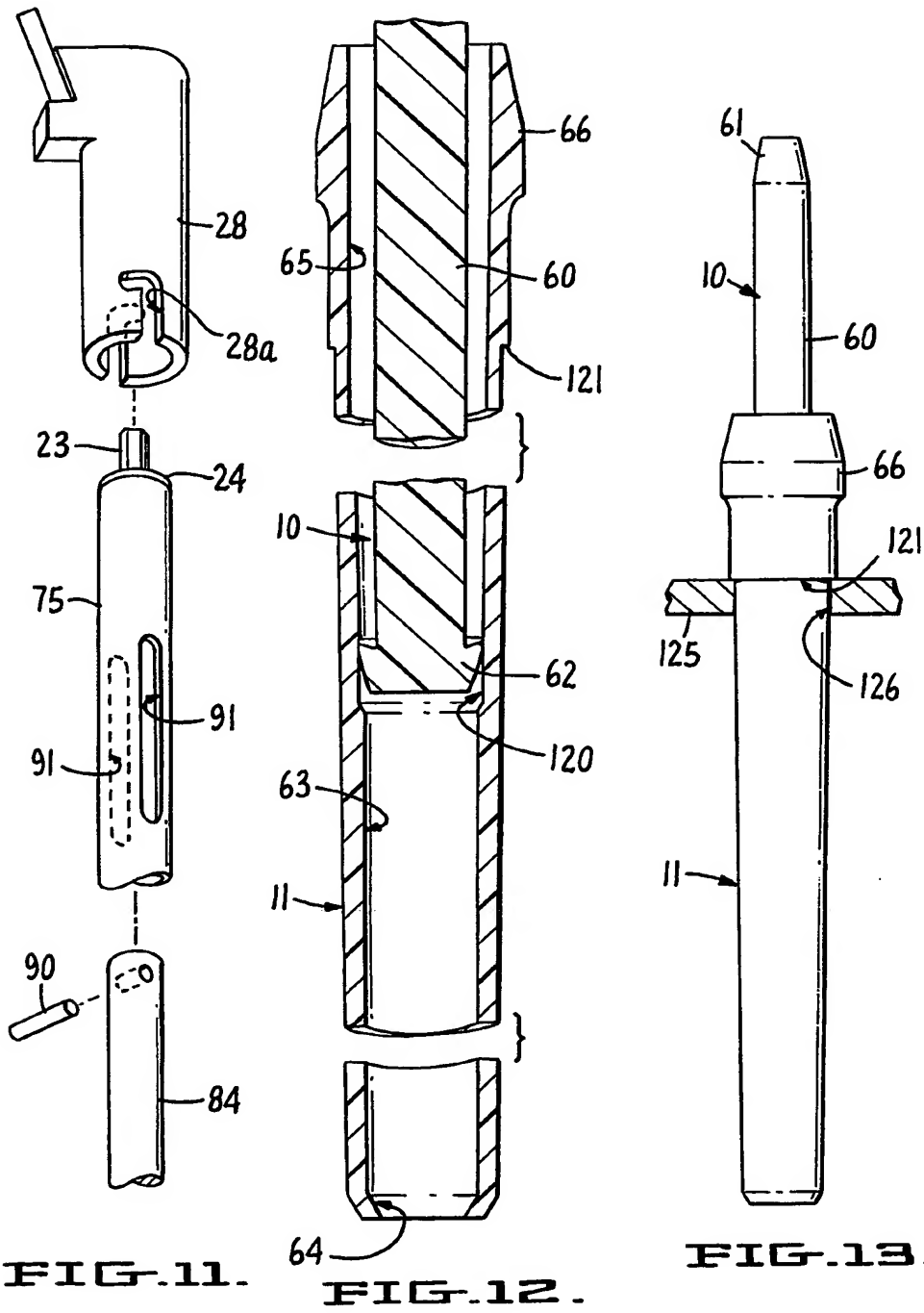


FIG. 10.



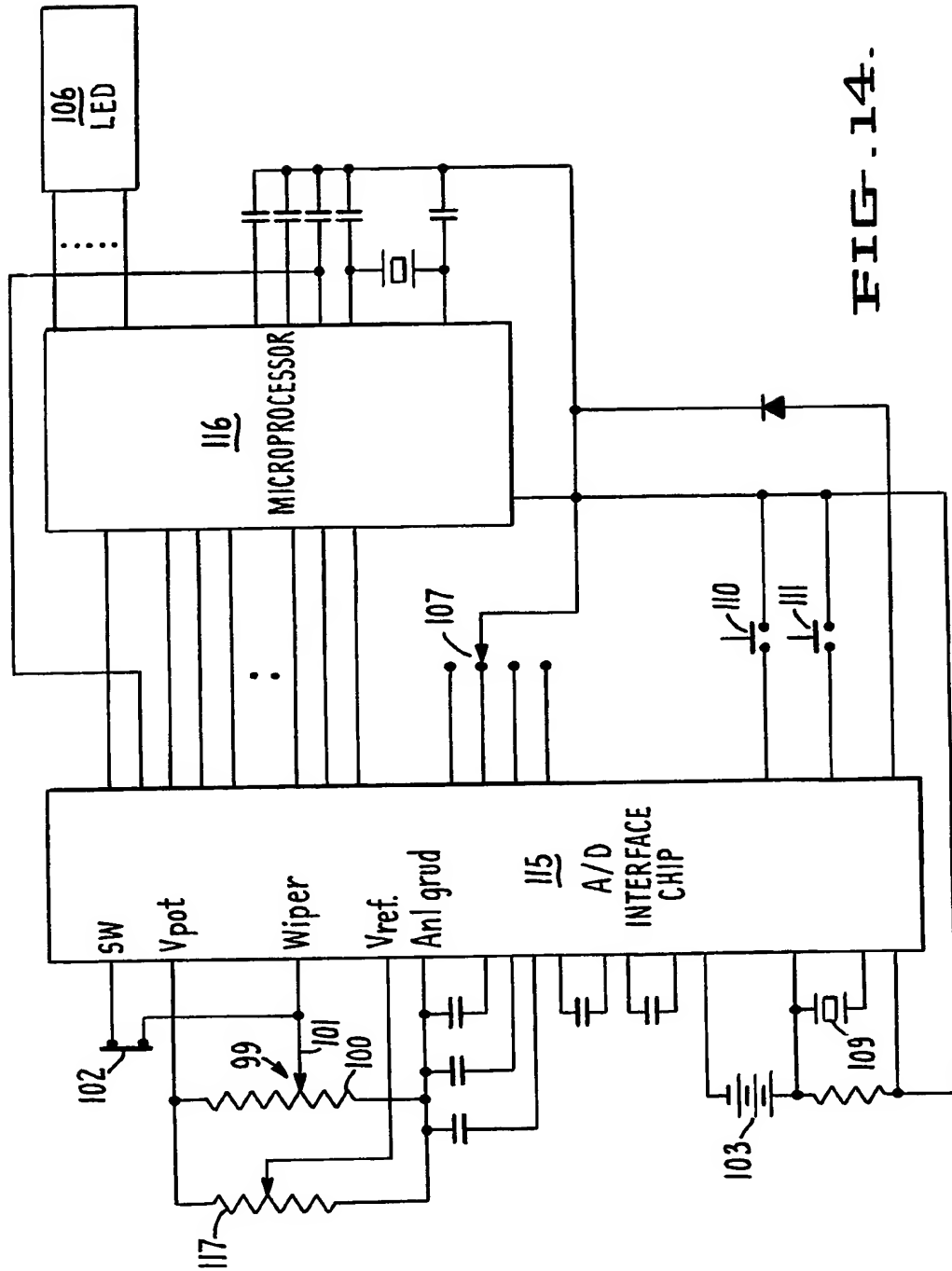


FIG. 14.

